Chapter 1 - Background Information

INTRODUCTION

The National Park Service (NPS) has instituted a program to inventory and monitor natural resources in approximately 270 park units across the nation. The program is being implemented by forming 32 ‘networks’ of parks that share common management concerns and geography. By funding these networks, the NPS hopes to minimize redundancy, maximize cost effectiveness, and increase consistency in data collection and information transfer.

The Great Lakes Inventory and Monitoring Network (hereafter, GLKN or the Network) is composed of nine national park units in Minnesota, Wisconsin, Michigan, and Indiana (Figure 1). The Network was formed in 1999 and began implementing a biological inventory program in 2000 (Route 2000). The Network’s biological inventory program is designed to gather baseline information on vertebrates and vascular plants in the nine parks. This includes cataloging existing information and implementing field inventories to fill critical gaps. Simultaneously, other programs within the NPS are gathering and summarizing information on air and water resources; developing state-of-the-art vegetation, soils, and geology maps; and designing web-based data systems for easy access to information throughout the NPS. These efforts were made possible by one of the largest increases in funding and staffing for natural resource management in the history of the NPS.

The Network received funding in 2002 to begin planning its Vital Signs monitoring program. Herein we describe the purpose and goals of the monitoring program, the Network’s organizational structure, the ecological and managerial context of the nine parks, the availability of and gaps in information, the process we used to determine what the Network will monitor for the nine parks, and finally, the prioritized list of what the Network intends to monitor. This report, referred to as the “Phase 2 Report,” will serve as chapters 1, 2, and 3 of the final monitoring plan.

Developing an ecological monitoring program requires an initial investment in planning and design to ensure that critical information needs are met and that results are clearly understood and readily available. Each network is required to design a monitoring program that addresses the Servicewide goals, yet is flexible enough to meet local ecological and managerial needs. To determine appropriate strategies and indicators, all networks are expected to take a phased approach to planning that incorporates five steps:

In Phase 1:

1. Catalog and summarize existing data and understanding of park ecosystems.
2. Develop conceptual models of relevant ecosystem components.

In Phase 2:

3. Develop specific monitoring objectives and select indicators.

In Phase 3:

4. Determine the appropriate sampling design and sampling protocols.
5. Implement data management, analysis, and reporting procedures.

Each network is required to document progress in Phase 1, 2, and 3 Reports, which when combined, will serve as the network's monitoring plan.

Table 1 shows how the Network has compiled information (steps 1 and 2) and funneled it through a series of park and focus group workshops to determine Vital Signs (step 3). Additionally, the NPS Water Resources Division (WRD) requires that, at a minimum, networks gather data on pH, specific conductance, dissolved oxygen, and temperature in any water body being monitored, and we have included these parameters in our Vital Signs.

In Phase 3 we expect to integrate monitoring of the newly determined Vital Signs with current park- and partner-funded efforts. This will likely involve a blend of strategies including: 1) incorporating data from ongoing park and partner monitoring, 2) augmenting park-based monitoring, 3) commissioning partners to conduct monitoring, and 4) having Network teams conduct monitoring. Regardless of who collects monitoring data, the Network will be responsible for design, quality control, data archival, analysis, and reporting.

Table 1. Timeline for the Great Lakes Inventory and Monitoring Network to complete the 3-phase process of planning and designing a long-term ecological monitoring program. An Inventory and Monitoring Advisory Committee (IMAC) of national, regional, network, and park level staff determines deadlines for major steps and reports.

Planning and design step	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006
Information gathering and data cataloging	X	X	X	X	X	X	
Inventories to support monitoring		X	X	X	X	X	
Park scoping workshops		X	X				
Conceptual modeling			X	X			
Indicator prioritization and selection					X		
Protocol development, monitoring design					X	X	X
Implement initial monitoring (with prior approval)							X
Monitoring plan due dates Phase reports 1, 2, 3					Phase 1 Oct. 03	Phase 2 Oct. 04	Phase 3 Dec. 05

Purpose of Ecological Monitoring in National Parks

National park managers are confronted with increasingly complex and challenging issues that require an understanding of the status and trends of park resources. Parks are mandated to understand, maintain, restore, and protect the integrity of natural resources (e.g., air, water, soils, native plants, and animals), processes (e.g., natural erosion, fire, photosynthesis, and succession), ecosystems, and values (e.g., scenic views) within their boundaries (NPS 2001). Natural and anthropogenic stressors from within park boundaries, as well as from beyond park boundaries impact the resources of the parks. Protecting park resources is a challenge that requires a multi-faceted, integrated approach, including specialized staff and partnerships. (Herein, partner is defined as any state or federal agency, tribal government, university, local governments, or non-governmental organization (NGO) that actively participates in monitoring, research, and/or management of natural resources in and adjacent to Network parks.)

An ecosystem approach to natural resource management is needed because no single temporal or spatial scale is adequate for all system components and processes. For example, the appropriate level for understanding and effectively managing a resource might be at the genetic, population, species, community, or landscape level. In some cases, it may require a regional, national, or international effort. National parks are part of larger ecosystems and must be managed in that context. Understanding the dynamics of park ecosystems and the consequences of human activities is essential for making decisions to maintain, enhance, or restore the ecological integrity of park ecosystems (Roman and Barrett 1999). Monitoring data help to define the normal limits of natural variation in park resources and can be used to examine impairment and initiate or change management practices. Monitoring data can also provide basic information for those wanting to know more about an area, or provide the context in which to analyze data from research or other monitoring. The intent of the NPS monitoring program is to track a subset of park resources and processes known as 'Vital Signs'. The task for each network is to select those Vital Signs that best indicate the overall condition of park resources, that respond in predictable ways to stressors, or that are of particular importance to people. Networks must furthermore ensure that monitoring data are readily available and relevant to the management of critical park resources.

Legislation, Policy, and Guidance

National park managers are directed by federal law and NPS policies and guidance to know the status and trends of natural resources under their stewardship. This is implicitly stated in the mission of the National Park Service: "*...to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generation*" (National Park Service Organic Act 1916).

More recently, the National Parks Omnibus Management Act of 1998 established the framework for integrating natural resource monitoring into park management. Section 5934 requires the Secretary of the Interior to develop a program of "*inventory and monitoring of National Park System resources to establish baseline information and to provide information on the long-term trends in the condition of National Park System resources*."

Congress reinforced this message in its FY 2000 Appropriations bill: "*The Committee applauds the Service for recognizing that the preservation of the diverse natural elements…… involves a serious commitment from the leadership of the National Park Service to insist that the superintendents carry out a systematic, consistent, professional inventory and monitoring program, along with other scientific activities, that is regularly updated to ensure that the Service makes sound resource decisions based on sound scientific data.*"

The 2001 NPS Management Policies specifically directed that: *"Natural systems in the National Park System, and the human influences upon them, will be monitored to detect change. The Service will use the results of monitoring and research to understand the detected change and to develop appropriate management actions."*

Further, *"The Service will:*

- *Identify, acquire, and interpret needed inventory, monitoring, and research, including applicable traditional knowledge, to obtain information and data that will help park managers accomplish park management objectives provided for in law and planning documents.*
- *Define, assemble, and synthesize comprehensive baseline inventory data describing the natural resources under its stewardship and identify the processes that influence those resources.*
- *Use qualitative and quantitative techniques to monitor key aspects of resources and processes at regular intervals.*
- *Analyze the resulting information to detect or predict changes, including interrelationships with visitor carrying capacities, that may require management intervention, and to provide reference points for comparison with other environments and time frames.*
- *Use the resulting information to maintain-and, where necessary, restore-the integrity of natural systems"* (National Park Service 2001).

Several other important statutes, such as the Clean Water Act and the Endangered Species Act, provide legal direction for determining the condition of natural resources in parks. For a description of the legislation and policy directives relevant to the monitoring program see Supplemental Document #1 and on-line at: http://science.nature.nps.gov/im/monitor/LawsPolicy.htm.

Goals for Vital Signs Monitoring

The purpose of this program is to identify and monitor Vital Signs of park ecosystems. A Vital Sign may be a physical, biological, or chemical element or process that indicates the health of a park ecosystem or responds to natural or anthropogenic stresses in a predictable or hypothesized manner, or may be an element that has high value to the park or the public (e.g., endangered species, charismatic species, exotic species). The NPS Vital Signs program is intended to monitor key elements of park ecosystems to help detect ecological problems that need further research or management action.

Specifically, Servicewide goals for Vital Signs monitoring (Fancy 2004) are to:

- *"Determine status and trends in selected indicators of the condition of park ecosystems to help managers make better-informed decisions and work more effectively with other agencies and individuals for the benefit of park resources.*
- *Provide early warning of abnormal conditions and impairment of selected resources to promote effective mitigation and reduce management costs.*
- *Provide data to better understand the dynamic nature and condition of park ecosystems and to provide reference points for comparisons with other altered environments.*
- *Provide data to meet certain legal and Congressional mandates related to natural resource protection and visitor enjoyment.*
- *Provide a means of measuring progress towards achieving performance goals that are mandated by Government Performance Results Act (GPRA)"*.

The Great Lakes Network adopts these Servicewide goals and further defines the intentions and limitations of the Network's program with the following provisions:

1. The majority of the Network's funding and efforts will be directed at monitoring trends in resource themes or issues that are common across Network parks and that individual parks would find difficult to accomplish due to high cost, magnitude of scale, or lack of expertise. This will increase staff efficiency and cost-effectiveness, promote sharing of data, and allow comparison of trends across the Network.

2. In cases where Vital Signs are already being monitored by one or more park(s), and the Network assumes the cost of monitoring, the park(s) agree(s) to re-allocate park-based funds and staff to other natural resource efforts in that park. Parks will continue to monitor various resources not monitored by the Network, conduct short-term assessments and field studies, and facilitate research.

3. The Network's monitoring program will be designed with quality of information in mind - not number of issues addressed. The objective is to provide quality data on a core set of resource indicators. Additional research and park-based monitoring can expand from this core set of indicators.

4. The Network will strive for multiple lines of evidence to document significant changes in resource status. Further, we expect that Vital Signs will provide a basis for developing and testing hypotheses for cause-and-effect research. It is the shared responsibility of the Network, each individual park, the Great Lakes Research and Education Center, and our science partners to uncover important trends in Vital Signs and look for funding to conduct such research.

5. The Network monitoring program will strive for consistency in long-term data collection yet allow for flexibility to alter or remove indicators that are not meeting objectives.

Performance Management Goals

In accordance with the Government Performance Results Act (GPRA), the NPS must develop 'performance management goals' (GPRA goals) and report on progress towards meeting them. The National Inventory and Monitoring (I&M) Program can help parks attain eight of these goals (Table 2). For example, the identification of Vital Signs indicators, goal Ib3, has been accomplished for the nine parks through the efforts of the Network. It may also be appropriate for the Network to monitor certain management actions, such as restoration of disturbed lands, which could help meet other GPRA goals.

Table 2. Performance management goals related to inventory and monitoring of parks in the Great Lakes Inventory and Monitoring Network. Class I air quality areas receive the greatest protection, with only small amounts of certain kinds of additional air pollution allowed; 303d-listing designates bodies of water that are out of compliance for particular pollutants; ORW designates Outstanding Resource Waters. Table adapted from Leibfreid (2003).

NPS strategic plan mission goals	Network parks involved
Ia1. Disturbed lands / exotic species – 10.1% of targeted disturbed park lands are restored, and exotic vegetation on 6.3% of targeted acres is contained.	All GLKN parks have invasive exotics and most have disturbed lands, especially INDU, SLBE, and MISS.
Ia2. Threatened and Endangered Species – 14.4% of the 1999 identified park populations of federally listed threatened and endangered species with critical habitat on park lands or requiring NPS recovery actions have improved status, and an additional 20.5% have stable populations.	All nine parks have listed species, but not all have critical habitat and not all species require NPS recovery actions.
Ia3. Air quality – Air quality in 70% of reporting park areas has remained stable or improved.	ISRO and VOYA are Class I air quality areas. ISRO, VOYA, SLBE, and INDU are currently monitoring some aspect of air quality.
Ia4. Water quality – 75% of 288 parks have unimpaired water quality.	303d listed waters occur in: GRPO, INDU, ISRO, MISS, PIRO, SACN, SLBE. ORW occur in: INDU, ISRO, MISS, PIRO, SACN, SLBE, VOYA.
Ia7. Cultural landscapes – 35% of the cultural landscapes on the Cultural Landscape Inventory with condition information are in good condition.	All 710 acres of GRPO are on the National Register of Historic Places as an Historic District. SLBE has 15 and APIS has 17 Cultural Landscapes in various stages of the designation process.
Ib1. National resource inventories – Acquire or develop 87% of the 2,527 outstanding data sets identified in 1999 of basic natural resource inventories for all parks.	All GLKN parks currently benefit from natural resource inventories; all still need additional natural resource inventories.
Ib3. Vital Signs – 80% of 270 parks with significant natural resources have identified their Vital Signs for natural resource monitoring.	All GLKN parks identified their Vital Signs in 2004.
Ib5. Aquatic resources – NPS will complete an assessment of aquatic resource conditions in 265 parks.	Baseline water quality reports are completed for all GLKN parks, but some are ~20 years old.

Organizational Structure and Function of the Network

The Network has an 11-member Technical Committee (also referred to as “ the Committee”) representing each of the nine parks, the regional office, and the Network office. The Committee has met each spring and fall to discuss and make decisions on the technical aspects of designing and implementing the program. Now that the Vital Signs have been chosen, the Committee will meet in spring only, and will conduct other necessary business electronically. The Network’s coordinator serves as the chair of the Committee, and other Network and park staff will attend Committee meetings as needed and as time allows. For decisions on hiring of permanent staff, significant allocations of funds, or the overall direction of the program, the Committee makes recommendations to a six-member Board of Directors. The Board of Directors consists of four of the nine park superintendents, and the regional and Network I&M coordinators. Superintendents on the Board rotate so that all nine park superintendents will eventually serve. The Board has met each spring and fall following Technical Committee meetings to facilitate fast action on any recommendations made by the Technical Committee. As with the Technical Committee, the Board will meet once a year beginning in FY05, and conduct other business electronically or via teleconference. Final authority on the overall program rests with the Board. The bylaws and decision-making process of the Technical Committee and Board of Directors are detailed in a Charter signed by all superintendents from the nine parks (Supplemental Document #2).

The Network’s Role and Function

The Network is accountable to each of the nine Network parks, the Midwest regional office, and ultimately to the National I&M Program, for all products funded under the I&M initiative. The Network facilitates and coordinates the planning, design, and completion of I&M efforts with advice from the Network parks, regional and Servicewide I&M staff, and the scientific community.

Staff and Administrative Support

The Network currently has three full-time, permanent employees, four term employees, and shares three permanent employees with other parks or NPS programs (Appendix A). Permanent GLKN staff include the coordinator, GIS specialist, and aquatic ecologist who work full-time for the Network. Four two-year term data specialists were hired in 2003; three are stationed in parks and the one stationed at the Network office was recently hired in the data manager position (leaving that data specialist position vacant). The inventory specialist is a two-year term position due to the temporary funding for that program. The data manager and administrative assistant are shared with the NPS Great Lakes Exotic Plant Management Team (EPMT), which is co-located with the Network. The information technologist is shared with Apostle Islands National Lakeshore (APIS).

Daily administrative functions are carried out by the Network’s administrative assistant, but most contracting, personnel actions, and administrative oversight are provided by APIS under a Memorandum of Understanding. The Network also obtains contracting services from other parks or the regional office when a higher-warranted officer is needed. The other eight parks provide some personnel actions and contracting services for studies specifically related to their parks and occasionally for multi-park efforts.

Facilities and Local Partnerships

The Network's office is co-located with the U.S. Geological Survey (USGS) - Biological Resource Division, the U.S. Fish & Wildlife Service (FWS)-Office of Fisheries Assistance, and the Great Lakes EPMT. The Network and the EPMT currently share two staff positions (explained above) and space. The partnership is likely to include joint responsibility for assessing the outcomes of exotic plant management by the EPMT.

Ashland is central to Network parks and has most essential support services, including access to cable communications for high-speed data transmission. The suite occupied by the GLKN and EPMT has office space with limited room for growth, a lab, a server/plotter room, a small library, and a conference room shared with the other government agencies.

Background

Ecological Overview of the Region

The Great Lakes I&M Network consists of nine national park units in Minnesota, Wisconsin, Michigan, and Indiana (Table 3, Figure 1). These parks extend from northern Minnesota to southern Lake Michigan, a distance of >1,050 km (650 mi). Four parks are located on Lake Superior, two on Lake Michigan, two on major river systems (Mississippi and St. Croix Rivers), and one is associated with a mosaic of large and small inland waters along the border between Canada and the United States. Thus, fresh water is a prominent natural resource shared by these parks. However, terrestrial resources are equally important because of management concerns stemming from a complex of roads, trails, campsites, and land-based facilities across a diversity of habitat types. The following summary provides an overview of the region and puts the parks into ecological context. For a summary of individual parks refer to Appendix B or visit each park's website through http://www1.nature.nps.gov/im/units/glkn/index.htm.

Cultural History

Network parks share a common history. Over the past three centuries, fur trade, logging, mining, farming, industrial development, and urbanization have dramatically changed the character and ecology of the areas the parks now protect (Nute 1931, Wells 1978). Fur traders began establishing posts in the mid-1600s (Ray 1987). Over the next two centuries, Native American and European trappers removed a staggering number of beaver (*Castor canadensis*) and other furbearers from the region (Schorger 1970).

Table 3. ALPHA code, size, and primary water association of the nine Great Lakes Inventory and Monitoring Network parks.

Park	ALPHA	Acres	Primary water association
Grand Portage National Monument	GRPO	710	Lake Superior
Indiana Dunes National Lakeshore	INDU	15,000	Lake Michigan
Mississippi National River and Recreation Area	MISS	53,776	Mississippi River
Apostle Islands National Lakeshore	APIS	69,372	Lake Superior
Sleeping Bear Dunes National Lakeshore	SLBE	71,189	Lake Michigan
Pictured Rocks National Lakeshore	PIRO	71,397	Lake Superior
Saint Croix National Scenic Riverway	SACN	92,735	St. Croix and Namekagon Rivers
Voyageurs National Park	VOYA	218,054	Border lakes and pond complexes
Isle Royale National Park	ISRO	571,790	Lake Superior
Total		1,164,023	

Figure 1. Location of nine parks in the Great Lakes Inventory and Monitoring Network and regional land cover. Land cover data from the National Land Cover Dataset by the U.S. Geological Survey (from Landsat imagery circa 1990).

Large-scale logging began in the 1800s. Most of the lands now within the parks were eventually logged to some degree (Callison 1967, Wells 1978). Dams were constructed in the 1800s and early 1900s to aid the transportation of logs and later used for power generation and navigation at MISS, SACN, and VOYA.

Intense fires often followed logging and destroyed seed sources and organic matter in the soil. Hunting to supply food for logging camps sharply reduced the number of ungulates and led to extirpation of woodland caribou (*Rangifer caribou*) and eastern elk (*Cervus elaphus*). Logging created habitat more favorable for white-tailed deer (*Odocoileus virginianus*) and the resulting range expansion of deer has significantly altered forest composition in some areas (Blouch 1984, Rooney et al. 2004). Deer also harbor a parasitic brainworm, *Pneumostrongylus tenuis*, which may limit recovery efforts for moose (*Alces alces*) and woodland caribou (Karns 1967). Some lands now protected within parks were also mined: brownstone at APIS, clay and gravel at SACN, copper at ISRO, gold at VOYA, and sand and gravel at INDU and SLBE.

Current Human Uses

Water levels continue to be controlled by dams within SACN, MISS, SLBE, and VOYA. These dams affect sediment transport, water temperatures and chemistry, and migration and dispersal of aquatic species. Visitors use parks in the region for a variety of recreational activities including canoeing, motor boating, kayaking, sailing, fishing, hunting, trapping, camping, swimming, hiking, cross-country skiing, snowmobiling, wildlife viewing, and personal solitude.

As some of our nation’s most pristine areas, the parks also offer opportunities for scientists and resource managers from state, federal, and tribal agencies to better understand natural processes and to compare protected lands with more disturbed landscapes.

Climate

The region has a primarily mid-continental climate with seasonal temperatures that vary widely between summer highs and winter lows. The large bodies of water associated with these parks cause temperature moderation, higher precipitation, and a slight seasonal shift to later summers on islands and immediate lakeshore areas in the Great Lakes parks (collectively known as lake-effects). Mean annual precipitation ranges from 64.5 to 90.7 cm (25.4 to 35.7 in), and temperatures can vary from minus 40^0C (-40^0F) in winter to over 32^0C (90^0F) in summer (Table 4; Appendix C). Annual snowfall ranges from 71.1 to 342.6 cm (28 to 135 in). Lake-effect snowfall near the Great Lakes causes this wide variation in snowfall within and among parks in the Network. SACN has two entries in Table 4 because significant climatic differences exist between the northern (Namekagon River) and southern (Lower St. Croix) reaches of the park due to latitude and topography.

Global climate change could have long-term ecological consequences for the region. Climate models suggest that temperatures around the Great Lakes will warm by 3 to 7^0C (5 to 12^0F) in winter, and by 3 to 11^0C (5 to 20^0F) in summer by the end of the century (Kling et al. 2003). Kling et al. (2003) offer evidence that Great Lakes winters are getting shorter, average annual temperatures are getting warmer, duration of lake ice cover is decreasing, and heavy rain events are becoming more common. If these predictions hold true, groundwater, surface water, wetlands, and other habitats could change dramatically and cause shifts in the distributions of many plants and animals.

Table 4. Climate of the Great Lakes Inventory and Monitoring Network parks. Data from the National Climatic Data Center - National Oceanic and Atmospheric Administration (NOAA), Cooperative Summary of the Day (TD3200) dataset; Jack Oelfke (personal communication) for ISRO. See Appendix C for information on how numbers were derived.

	Annual temperature		**Annual precipitation**		**Annual snowfall**		**Growing season**	
Park	**Mean °C (°F)**	**Range °C (°F)**	**Mean cm (in)**	**Range cm (in)**	**Mean cm (in)**	**Range cm (in)**	**Mean (# days)**	**Range (#days)**
APIS	5.3 (41.5)	3.4-6.9 (38.1-44.4)	78.5 (30.9)	47.2-116.8 (18.6-46.0)	234.4 (92.3)	101.6-430.3 (40.0-169.4)	140	100-180
GRPO	3.6 (38.5)	2.7-5.7 (36.9-42.3)	76.7 (30.2)	55.4-99.6 (21.8-39.2)	165.1 (65.0)	76.2-264.2 (30.0-104.0)	126	102-147
INDU	10.1 (50.2)	8.6-11.7 (47.5-53.1)	90.7 (35.7)	63.5-133.1 (25.0-52.4)	111.8 (44.0)	43.2-167.6 (17.0-66.0)	170	133-201
ISRO	1.1 (34)	not available	66.0 (26.0)	not available	71.1 (28.0)	not available	not available	not available
MISS	7.3 (45.1)	4.8-10.5 (40.6-50.9)	69.9 (27.5)	29.2-102.1 (11.5-40.2)	134.9 (53.1)	53.6-257.8 (21.1-101.5)	163	124-207
PIRO	5.4 (41.7)	3.0-7.1 (37.4-44.8)	88.1 (34.7)	65.5-121.4 (25.8-47.8)	342.6 (134.9)	108.5-510.0 (42.7-201.2)	118	74-176
SACN-N	5.7 (42.3)	3.1-8.8 (37.6-47.8)	70.9 (27.9)	26.7-115.1 (10.5-45.3)	125.2 (49.3)	45.7-247.9 (18.0-97.6)	119	72-166
SACN -S	7.8 (46.0)	5.9-10.4 (42.6-50.7)	77.5 (30.5)	49.0-114.0 (19.3-44.9)	104.6 (41.2)	34.5-191.5 (13.6-75.4)	157	122-195
SLBE	7.6 (45.7)	6.1-9.6 (43.0-49.3)	87.9 (34.6)	61.7-132.1 (24.3-52.0)	322.6 (127.0)	147.3-505.5 (58.0-199.0)	148	93-190
VOYA	6.5 (43.7)	0.7-6.6 (33.3-43.9)	64.5 (25.4)	43.4-89.4 (17.1-35.2)	151.1 (59.5)	63.8-330.2 (25.1-130.0)	122	59-158

Native Vegetation

The Network parks span two ecological provinces described by McNab and Avers (1994) - the Laurentian mixed forest and eastern broadleaf forest. Blouch (1984) also describes the area as a transitional vegetation zone between the northern boreal forest and southern broadleaf forests (Fig. 1).

Quaking aspen (*Populus tremuloides*) and paper birch (*Betula papyrifera*) typically dominate disturbed forest areas. The forest types of less disturbed areas tend to reflect the region's soil and moisture regimes. Sugar maple (*Acer saccharum*), yellow birch (*Betula alleghaniensis*), American beech (*Fagus grandifolia*), white pine (*Pinus strobus*), and eastern hemlock (*Tsuga canadensis*) occupy the more fertile soils, while jack pine (*Pinus banksiana*) and red pine (*Pinus resinosa*) typically grow in more nutrient-poor and arid sandy soils. Oak (*Quercus* spp.) stands are common in moderately poor and dry soils. Black and white spruce (*Picea mariana* and *P. glauca*) and balsam fir (*Abies balsamea*) prevail in moist northern areas. Black spruce, northern white cedar (*Thuja occidentalis*), and speckled alder (*Alnus incana*) dominate conifer swamps. In the southern areas, beachgrass (*Ammophila breviligulata*), little bluestem (*Andropogon scoparius*), and sand cherry (*Prunus pumila*) dominate sand dunes and beaches. Riparian areas are typically dominated by silver maple (*Acer saccharinum*), American elm (*Ulmus americana*), and cottonwood (*Populus deltoides*) where exposed soil is present and cattail (*Typha latifolia*) where there is standing water.

<u>Fauna</u>

Although disturbed by past human activities, the Network park ecosystems still contain most species of pre-European settlement wildlife. Extirpation of native fauna and invasion of exotics tends to be greatest at the southern end of the region. The southern portions of the region are highly fragmented, dominated by human development, and include large cities such as Gary, Indiana; Chicago, Illinois; and Minneapolis-St. Paul, Minnesota. The aquatic environment supports a variety of fishes, amphibians, reptiles, semi-aquatic mammals, and waterfowl. White-tailed deer, which have greatly increased in number and range, are the dominant ungulates. Black bear (*Ursus americanus*), coyote (*Canis latrans*), and red fox (*Vulpes fulva*) are typical terrestrial carnivores. Gray wolves (*Canis lupus*), which were extirpated from all GLKN parks except ISRO and VOYA, have steadily increased; they now occur regularly in GRPO and SACN and occasionally in APIS and PIRO. Bald Eagles (*Haliaeetus leucocephalus*), Osprey (*Pandion haliaetus*), and other avian species high on the food chain are recovering from declines in the middle of the twentieth century caused by DDT and other pollutants (Gerrard and Bortolotti 1988). Beaver, which were once decimated by the fur trade, have returned in great number and are again a major force in shaping the landscape in some GLKN parks.

<u>Surface Water</u>

Lakes - The Great Lakes consist of five large lakes: Superior, Michigan, Huron, Erie, and Ontario. Six parks are immediately adjacent to Lake Superior or Lake Michigan (Table 3). The combined total surface area of these two lakes (140,000 km^2 (54,000 mi^2)) and volume (17,000 km^3 (4,080 mi^3)) has a dramatic affect on weather, species distributions, animal migration patterns, and human impacts. Tens of thousands of smaller lakes ranging from < 10 to > 10,000 hectares dot the region with density generally increasing from south to north. VOYA, for example, has a complex of 30 lakes and hundreds of ponds. Lakes in the region vary greatly in productivity, but are generally ringed with aquatic plants (macrophytes) and provide habitat for fishes, amphibians, reptiles, semi-aquatic mammals, and a variety of waterfowl and other birds (LaBounty 1986).

Rivers - The Upper Mississippi River and its tributaries, including the St. Croix and Namekagon Rivers, span a latitudinal distance of over 1,280 km (800 mi) (Theiling

1996). Numerous smaller rivers and creek systems drain the region's surface waters down the Mississippi River to the Gulf of Mexico (SACN and MISS), northeast through the Great Lakes (GRPO, APIS, ISRO, PIRO, SLBE, and INDU), or north to Hudson Bay (VOYA).

Ponds and other wetlands - Hundreds of thousands of ponds and wetlands are interspersed through the region; like lakes, these become more frequent in the more northerly regions. These ponds and wetlands are sometimes associated with beaver activity. Beaver ponds and associated wetlands form some of the most productive wildlife habitats in the region (Omart and Anderson 1986, Weller 1986).

Summary of Past and Ongoing Aquatic Studies

A variety of aquatic resource investigations have taken place at Network parks since the parks were established. At many parks, these studies have been primarily descriptive, providing general characterizations of park waters and assessments of basic physical, chemical, and/or biological conditions. All Network parks have baseline water quality information for at least some of their waters. This information varies in quality, is sometimes dated, and may include early qualitative surveys as well as more recent inventories and quantitative studies. Benthic invertebrate community assessments have been undertaken in several Network parks since the 1980s. Phytoplankton, zooplankton, and aquatic macrophytes are less frequently studied, and functional aspects of aquatic ecosystems (productivity, nutrient cycling, etc.) are not usually considered. Aquatic wildlife and amphibians have been the subject of inventory and monitoring studies, but rarely the topic of specific research questions. Fisheries investigations have varied among parks, but have consisted largely of surveys and assessments. Much of the fisheries information available for parks comes from state investigations. U.S. Geological Survey streamflow gauges are located in or near all parks except PIRO, and in some cases, are also used for water quality monitoring or research project sites. See Table 7, in the "Summary of Current Monitoring in Parks" section, below, for types of aquatic monitoring currently conducted in GLKN parks.

Several parks have developed or are developing water resource management plans (SACN, SLBE, VOYA, and ISRO). Water resources scoping projects, assisted by the NPS Water Resources Division (WRD) planning program, will soon be undertaken at MISS (>2004) and PIRO (>2004). These documents play a key role in prioritizing research needs and maintaining continuity in park aquatic research activities.

A detailed aquatic synthesis of all nine GLKN parks has been prepared as a technical report (Moraska Lafrancois and Glase 2004). For each park, the authors describe the basic aquatic resources; summarize past aquatic-related research, inventory, and monitoring efforts; identify the strengths and gaps in aquatic resource programs; and make recommendations for monitoring and research. This aquatic synthesis also includes information relevant to the Network as a whole, such as a summary of aquatic projects undertaken in parks by aquatic theme (e.g., water quality, contaminants, mussels, fish). The authors point out apparent needs for inventory, monitoring, and research across the Network, and provide recommendations.

Summary of Past and Ongoing Terrestrial Studies

The majestic nature of many Network parks has long been a draw for terrestrial researchers, with many early studies of terrestrial resources conducted prior to the National Park designations. These early studies (1900 - 1950) tended to focus on the compilation of species lists, especially of a region's flora. For example, plant species lists were compiled for ISRO in 1914 and for SLBE in 1918. More current terrestrial research has focused on the relationships of species with their larger environment. Common themes shared by many parks include the effects of deer browse on vegetation, anthropogenic influences on bears, and the role of fire on park ecosystems. Most recently (1990 - present), species-environment studies have addressed conservation issues for taxa of concern. Notable examples include research at INDU on the native plant *Lupinus perennis*, the only food source of the federally endangered Karner blue butterfly (*Lycaeides melissa samuelis*). The species-environment relationship was also studied at SLBE, where the Lakeshore's open lands, maintained for their cultural significance, were examined for their importance to declining grassland bird communities.

While most terrestrial studies address a single point in time, several have examined longer time frames. Surveys of deer at INDU and MISS, wolves at ISRO and moose at GRPO are, or have been, conducted annually. Breeding bird surveys are also conducted annually at most of the Network parks, and a Christmas bird count has been conducted at INDU since 1953. Long-term studies have not been limited to species surveys. In what is considered a hallmark of long-term research, the population dynamics of the wolf-moose predator-prey system at ISRO have been examined since the early 1960s.

A summary of studies of terrestrial resources at the nine parks in GLKN is available in Supplemental Document #5. The authors provide a synopsis of research from each park with a focus on floral, mammalian, and avian studies.

Summary of Air Quality Information

The NPS Air Resources Division (ARD) conducted a synoptic overview of air quality monitoring considerations for Network parks and it is available as a technical report (Maniero and Pohlman 2003). The following is a summary of conclusions from that report.

Ambient air quality in Network parks appears to be generally well monitored. All nine parks have wet deposition (i.e., National Atmospheric Deposition Program/National Trends Network (NADP/NTN)) sites within 56 km (35 mi) of their boundaries. With the exception of VOYA, which has a dry deposition (i.e., Clean Air Status and Trends Network (CASTNet)) site, all other parks are between 72 km (45 mi) and 264 km (165 mi) from the nearest CASTNet site. The distance between parks and CASTNet monitoring is not unusual given the small number of CASTNet monitors across the country. The relative abundance of wet deposition monitors is probably appropriate because the bulk of the deposition in this area (approximately 85% at VOYA) is in the form of wet deposition.

Most Network parks have ozone monitors within 40 km (25 mi) of their boundaries. APIS is the exception with the nearest ozone monitor 112 km (70 mi) away.

Parks with Class I airsheds (VOYA and ISRO) have on-site Interagency Monitoring of Protected Visual Environments (IMPROVE) monitors. (Class I, II, and III areas are Congressional classifications designed to prevent deterioration of air quality. Class I airsheds receive the greatest protection and Class III the least.) For other parks, proximity to an IMPROVE monitor largely depends on how close the park is to a Class I park or another Class I area (such as the Boundary Waters Canoe Area Wilderness or the Seney National Wildlife Refuge (NWR)). The distance of parks with Class II airsheds from IMPROVE monitors range from 40 to 224 km (25 to140 mi). Monitoring visibility at scenic vistas with digital cameras is possible, and while not adequate for regulatory purposes, it is useful for documenting visibility conditions and trends, and providing a means of sharing that information with the public. Cameras are currently located at Seney NWR, Michigan, approximately 50 km (31 mi) from PIRO, and Grand Portage Indian Reservation, Minnesota, adjacent to GRPO (http://www.mwhazecam.net/).

A fair amount of ambient air toxics monitoring has been and is being conducted in the Great Lakes area. These efforts do not seem to be well coordinated on a regional basis, and the data from the various monitoring programs are not readily available. Air toxics may be an issue for many Network parks. A great deal of toxics effects monitoring and research has been conducted at INDU, ISRO, MISS, SACN, and VOYA. For good reason, monitoring at ISRO and VOYA has focused on mercury and its effects. Additional previous work at ISRO focused on atrazine and PCBs. Very little, or no, monitoring of air toxics effects has been conducted at APIS, GRPO, PIRO, or SLBE. ARD also looked at park water quality data relative to atmospheric deposition for all nine Network parks. The data indicated surface waters at APIS (e.g., at Oak Island, Outer Island, and Stockton Island) are sensitive to acidification from atmospheric deposition. Nitrogen deposition associated eutrophication may be a concern for INDU and MISS.

Ozone sensitive vascular plant species have been identified for all of the parks in the Network. Ozone concentrations may be high enough in INDU, PIRO, and SLBE that foliar injury surveys are warranted. An ARD-funded risk assessment completed for Network parks in June 2003 will provide further guidance on the likelihood of ozone-induced vegetation damage.

Summary of Water Resource Threats and Legal Status

Water is a major natural resource of the nine GLKN parks, and NPS mandates clearly state the need to protect water resources. The NPS Strategic Plan 2001-2005 provides goals and guidelines for water quality. In the Omnibus Management Act of 1998, Congress required that park managers provide a "*program of inventory and monitoring of the National Park System resources*."

The majority of Network parks have good water quality (Table 5). However, the amount of historic water quality data available for each park varies widely, which makes comparisons difficult (see Ledder 2003 for a complete discussion). Atmospheric deposition and surrounding land use practices are two of the most common threats to water quality in the parks. Three parks (INDU, MISS, and SACN) are located in urban settings and have been negatively impacted by residential and industrial activities. Seven parks have one or more water bodies listed in the corresponding state 303(d) list of impaired water bodies due to air deposition of toxics and land use practices. Conversely, eight parks contain water bodies considered to be Outstanding Resource Waters (ORW) by the corresponding state, including seven of the same parks with 303(d) designated waters (Tables 5 and 6).

Regulations for maintaining water quality in Network parks include Water Quality Standards in Minnesota, Wisconsin, Michigan, and Indiana. All but three parks are located in the Great Lakes Basin and fall under the Great Lakes Water Quality Agreement between the United States and Canada.

Table 5. Summary of threats to water resources at the nine National Park Service units in the Great Lakes Inventory and Monitoring Network.

Park	State	Data	Threats to water resources	Documented problem parameters*	Waterbody legal status#
Apostle Islands NL (APIS)	WI	1968-1996	Appears to be good quality. Atmospheric deposition and water traffic/recreational use. Highly erodible soils and often severe spring runoff.	None documented	None designated
Grand Portage NM (GRPO)	MN	1968-1995	Appears to be good quality. Relatively little water quality data. Atmospheric deposition, light recreational use, and logging in surrounding areas.	Pigeon River outside boundary 303d-listed for mercury	Pigeon River outside boundary is 303(d) listed
Indiana Dunes NL(INDU)	IN	1935-1992	Impacted by industrial/municipal effluents, surface runoff, sulfur and nitrous oxides, altered hydrologic processes, exotic species, and drain and fill of wetlands.	PCBs, PAHs, metals, pesticides, fuels and oils, indicator bacteria, biota	Outstanding Resource Waters (ORW), 303(d) listed waters
Isle Royale NP(ISRO)	MI	1962-1987	Appears to be very good quality. Atmospheric deposition, visitor activities, and waste.	Mercury, PCBs	303(d) listed waters Whole park ORW
Mississippi NRRA (MISS) +	MN	1926-1994	Heavily impacted by industrial/municipal waste water discharges, stormwater runoff, commercial and residential development, contaminated sediments, and erosion.	Dissolved oxygen, metals, indicator bacteria	303(d) listed waters Headwaters ORW
Pictured Rocks NL(PIRO)	MI	1968-1984	Appears to be good quality. Atmospheric deposition, surrounding land use practices and development, invasive species, and viewshed impacts.	None documented	303(d) listed lake Whole park ORW
Saint Croix NSR (SACN) +	WI	1926-1995	Impacted by development, industrial/municipal wastewater discharges, surface runoff, agriculture, cranberry industry, and recreational use.	Dissolved oxygen, metals, indicator bacteria, mercury, and PCBs.	ORW rivers 303(d) listed lakes and flowages on the rivers
Sleeping Bear NL (SLBE)	MI	1962-1996	Appears to be good quality. Atmospheric deposition, non-native species, septic leakage, wastewater, runoff, and recreational use.	None documented	303(d) listed lakes Whole park ORW
Voyageurs NP (VOYA) +	MN	1967-1991	Appears to be good quality. Atmospheric deposition, human use and adjacent landuses. Naturally occurring low yield aquifers may limit groundwater use.	Mercury, PCBs, fuels, waste water	Whole park ORW

* Denotes historic data gathered in "Baseline Water Quality Inventory and Analysis Reports".
# Denotes Water Quality Standards and state lists
+ Park not in Great Lakes Basin

Table 6. Waterbodies in the Great Lakes Inventory and Monitoring Network with legal designation.

Park	Waterbody	Legal status	Reason for 303(d)
GRPO	Pigeon River (outside of park boundaries) Lake Superior	303(d) ORVW	Hg
INDU	Grand Calumet River Little Calumet River Lake Michigan all waterbodies	303(d) 303(d) OSRW OSRW	FCA for PCBs & Hg; CN, oil, pesticides, impaired biota, *E.coli*, Cd, Zn, PAH *E.coli*, CN, pesticides, DO
ISRO	Siskiwit Lake Lake Superior all waterbodies	303(d) OIRW/303(d) OSRW	FCA for PCBs, Hg FCA for PCBs, Hg, chlordane, dioxin
MISS	Mississippi River Mississippi River (portions)	303(d) ORW	aquatic life, turbidity, PCB, bacteria
PIRO	Grand Sable Lake Lake Superior all waterbodies	303(d) OIRW OSRW	Hg
SACN	St. Croix Flowage Minong Flowage Yellow Lake Mud Hen Lake Sunrise River Goose Creek St. Croix River Namekagon River Kettle River	303(d) 303(d) 303(d) 303(d) 303(d) 303(d) ORW/303(d) ORW ORW	Hg Hg Hg Hg aquatic life, impaired biota, indicator bacteria excessive nutrients bioaccumulative toxins
SLBE	Big Glen Lake Little Glen Lake all waterbodies	303(d) 303(d) OSRW	FCA-PCB, chlordane, Hg FCA-PCB, chlordane, Hg
VOYA	all waterbodies	ORVW	

303(d) = impaired waterbody
PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl
OIRW - outstanding international resource water
ORVW = outstanding resource value waters (Minn. designation)
ORW = outstanding resource waters (Wis. Designation)
OSRW = outstanding state resource waters (Ind. & Mich. designations)
FCA= fish consumption advisory for atmospheric deposition

Summary of Current Monitoring in Parks

Network staff are cataloging and evaluating monitoring projects that are ongoing in the nine parks. This work is a component of the overall data mining effort being conducted by the Network's data specialists. The extent of monitoring efforts varies among parks, and is a consequence of park size, longevity, and natural resource program funding.

Network-wide, at least 217 projects with over 1300 cumulative years of data collected have been conducted by NPS staff, other agencies, and academic partners (Table 7). The number of projects is subjective because each park counts them differently. For example, one park may count five field sessions to monitor five species of invasive plants as five projects, while another park may count the entire effort as one monitoring project for invasive plants. Regardless, Table 7 and Figure 2 illustrate the relative effort among natural resource subjects. The greatest monitoring efforts in parks have been on birds, plants, and water quality, in that order (Figure 2). Much of the bird monitoring follows standardized protocols such as those of the breeding bird survey (BBS), or those recommended by Howe et al. (1997), but significant efforts are directed at specific species or assemblages such as Bald Eagle, colonial water birds, and Piping Plover. Most plant monitoring revolves around non-native, sensitive, and rare species. Some selected plant communities (e.g., sand dune communities) or species (e.g., Canada yew (*Taxus canadensis*)) are also being monitored and several parks are cooperating with the U.S. Forest Service to gather Forest Health Monitoring (FHM) plot data. Most Network parks or their partners are monitoring basic water chemistry and some indication of flow or lake level. Other significant efforts include air quality, fire effects (fuels and vegetation changes), fish communities, amphibian call surveys, white-tailed deer, and human impacts. The most notable long-term study is the wolf/moose predator prey study on Isle Royale. This study, which is currently conducted by Rolf Peterson from Michigan Technological University with support from the NPS, has been going on for over 40 years, and has resulted in numerous scientific and public interest publications. Refer to Supplemental Document #3 for a complete listing and abstracts of unpublished reports on ecological monitoring in Network parks, and Supplemental Document #4 for important published literature on ecological monitoring.

Current monitoring projects within the Network parks provide a good basis for a more focused GLKN monitoring program. Considerable information can be gleaned from these projects. For example, data variability, logistical constraints, and relative estimates of cost will all be essential for the future development of the Network program.

Unfortunately, few of these efforts are well analyzed and reported. In 2003, the Network contracted with the University of Minnesota, Natural Resources Research Institute (NRRI) to analyze and summarize water quality monitoring data collected in the nine parks. They will also make recommendations for improvement in monitoring methods, including a Network-wide strategy for monitoring water quality in the future. The Network also hired a private contractor in 2003 to critique the parks' monitoring of herpetofauna. The contractor's final report included recommendations for consistency across the parks as well as for methods specific to individual parks. In FY04, the Network selected contractors to assess park data for the additional monitoring themes of bioaccumulation of toxins, terrestrial vegetation, breeding landbirds, and deer browse.

Table 7. Current monitoring efforts by the National Park Service and its partners in the Great Lakes Inventory and Monitoring Network. Numbers reflect total known projects in each category.

Ecosystem component	Great Lakes Network Parks									
	APIS	GRPO	INDU	ISRO	MISS	PIRO	SACN	SLBE	VOYA	Total
Air resources										
Meteorology			1	1				1		3
Air quality	1		1	1				1	1	5
Ozone			1	1					1	3
Mercury and other pollutants			1					1		2
Acid rain			1	1						2
Fire weather			1					1		2
Water quality										
Physical: temp., cond., pH, clarity	1	1	1		3	1	1	1	2	11
Nearsore bacteriology			1					1		2
Riparian – Riverwatch			1		1					2
River flow/river flow/lake levels					2		2	1	1	6
Sedimentation					1			1		2
Geology and landscape processes										
Bluff erosion	1							1		2
Sandscape/beach erosion	1		1			1	1			4
Fire/habitat processes			3	2					1	6
Hydrology								2		2
Land use monitoring					3			1		4
Plants										
Selected plant communities	2	1	2		1	1		1	1	9
Exotic plants	2		2	1	1	2	2	4	1	15
Sensitive, rare and threatened plants	2		3	1		1	1	3		11
Plant health and disease			1	1		2			2	6
Invertebrates										
Aquatic invertebrate communities					2				1	3
Sensitive, rare and threatened species			1				1	1		3
Gypsy moth	1		1	1		1		1	1	6
Zebra mussel						1	1	1	1	4
Other exotic invertebrates				1					1	2
Fisheries										
Salmonids – coaster brook trout, etc.		1		1		1				3
Nearshore fisheries		1	1						1	3
Sportfish harvest									4	4
Fish ecosystem					3		1		3	7
Exotic fish						1				1
Reptiles and amphibians										
Anuran call survey	1		1	1	1	1	1	1		7
Other herp community				1			2			3
Amphibian deformity				1						1
Birds										
Breeding bird survey	1	1	1	1	1	1	1		1	8
Migratory bird survey	1									1
Winter bird survey							1			1
Colonial waterbirds	1		1	1			1	1	2	7
Game birds	2	1								3
Bald eagle	1			1		1	1	1	2	7
Piping plover	1		1			1		1		4
Other avian T&E species							1	1		2
Special concern avian species			5	1				2	2	10
Mammals										
Ungulates	1	1	2		1			1	2	8
Beaver	1			1			1		2	5
Black bear	1					3			1	5
Timber wolf				1						1
Other mammal							2		1	3
Human uses										
Human impacts				1			3	1	1	6
Total	22	7	35	22	20	19	24	32	33	217

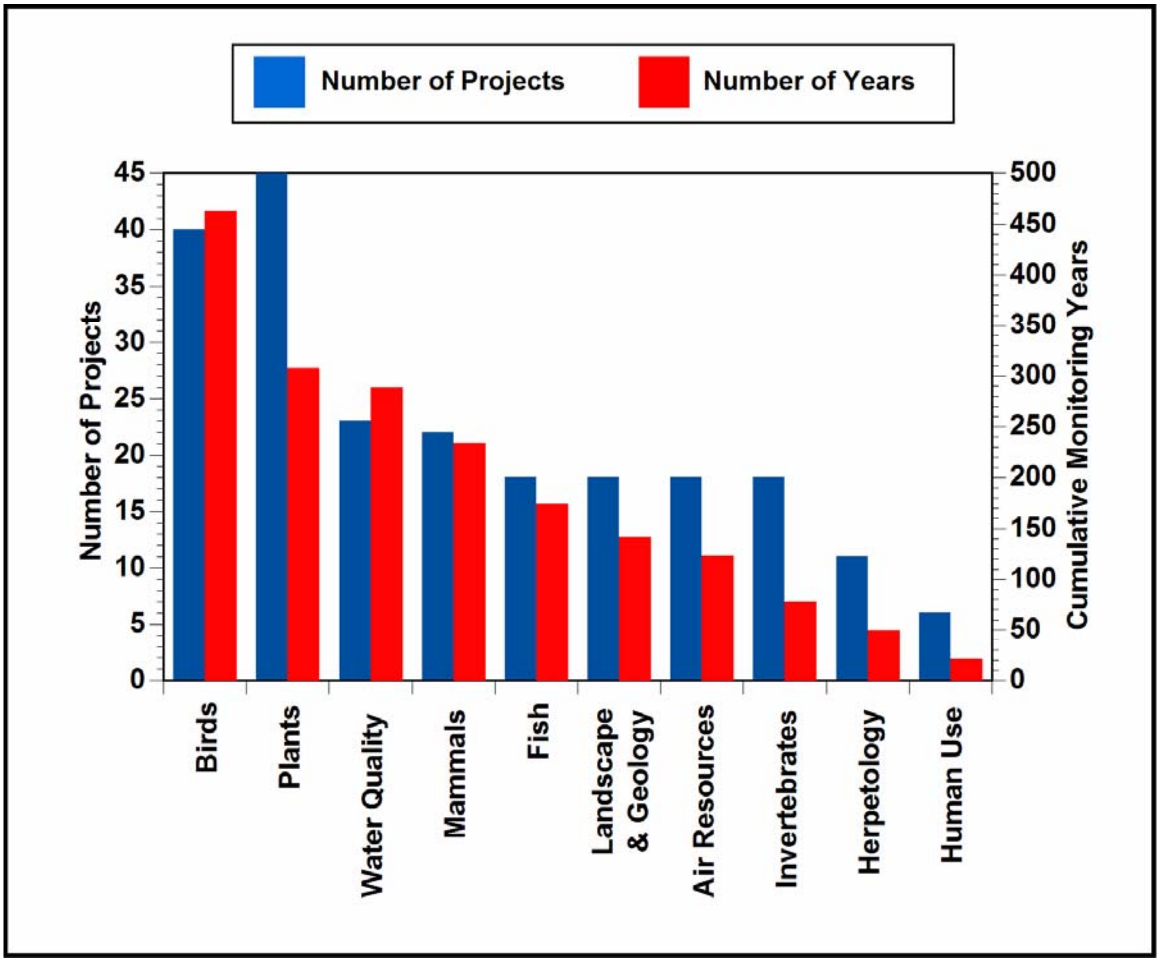

Figure 2. Summary of the number of projects and cumulative years of data collected for all known monitoring activities in National Park Service units of the Great Lakes Inventory and Monitoring Network. This summary includes efforts by NPS staff and numerous other agency and university partners.

Significant Monitoring Programs in the Great Lakes Region

Several important monitoring efforts are being conducted by partners around the region. Most of these are captured in the 'current monitoring' discussion above. Three additional programs that are significant to the Network's goals are summarized below.

State of the Lakes Ecosystem Conference (SOLEC): (www.on.ec.gc.ca/solec)

Canada and the United States are parties to the Great Lakes Water Quality Agreement (GLWQA). In 1994, the U.S. Environmental Protection Agency (EPA) and Environment Canada began hosting the biennial State of the Lakes Ecosystem Conferences (SOLEC) to report on the condition of the Great Lakes ecosystem and the major factors impacting it. After each conference, the EPA and Environment Canada prepare a report on progress towards achieving the purpose of the GLWQA: *to restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Ecosystem*. SOLEC partners include all major federal, state, and provincial agencies and NGOs in both countries. The partners have selected 80 indicators that reflect conditions of the Great Lakes basin and its major components. Currently 33 indicators are being reported on, but more indicators are incorporated at each conference.

The Network considered the 80 SOLEC indicators during focus meetings for the selection of Vital Signs. Many of the SOLEC indicators are not appropriate to the GLKN because of scale and different goals; however, some were included on GLKN's list. The Network's coordinator serves on the SOLEC Steering Committee.

Great Lakes Ecological Indicators (GLEI) program: (http://glei.nrri.umn.edu)

The EPA is funding the University of Minnesota's Natural Resources Research Institute to conduct a four-year evaluation of ecological indicators for the Great Lakes Basin. The study involves a rigorous research design to test field methods, statistical models, measurability, and overall relevance of a suite of indicators for nearshore and terrestrial components of the Great Lakes Basin. The field portion of the study will conclude in 2005, with data analyses occurring for one to several years later. The principal investigator for the GLEI program serves on GLKN's Science Advisory Group.

Amphibian Research and Monitoring Initiative (ARMI): (http://.armi.usgs.gov)

The USGS Amphibian Research and Monitoring Initiative (ARMI) formed in 2000 over concern for worldwide population declines and physical deformities in amphibians. Because of their close association with aquatic habitats and sensitivity to environmental stresses, amphibians are considered good indicators of general ecosystem health. ARMI's purpose is to measure, understand, and respond to the effects of environmental change on the nation's amphibians. ARMI's North Central regional coordinator is stationed at the Upper Midwest Environmental Science Center in La Crosse, WI.

The Network and ARMI have a joint project to inventory amphibians and reptiles at SACN, MISS, and VOYA. The Network expects to continue this partnership and intends to cost- share monitoring activities at other Network parks in the future. The coordinator for the ARMI program also serves on GLKN's Science Advisory Group.